What leads it to enter some river and seek a spawning ground? Surely, not a blind instinct or some inscrutable impulse. In the sea environmental conditions are more variable and change violently and suddenly. Periodically storms modify currents; schools of fish are broken up and scattered widely. Even under generally favorable conditions only 20 or rarely 40% of tagged fish have made the short journey to the places where keen-eyed watchers were waiting for them. Why did this marvelous instinct fail them? Is it not more reasonable to suppose that in shifting waters some were brought into new environmental conditions. In these they responded naturally to the same stimuli that had led their ancestors for unnumbered generations. But those stimuli under the changed conditions lead them to a new goal. Complex as the ocean is, one finds there the same environmental stimuli, mechanical, physical, or chemical, that are in fresh water, and these guide the salmon to some suitable stream for the last phase in its life cycle.

The address was illustrated by a series of lantern slides and figures made from photographs of conditions in nature taken in the course of studies in the field, and by maps of the regions covered. Some further detailed explanations were presented in connection with slides and maps as shown.

PALEONTOLOGY.—*A fossil catfish* (Felichthys stauroforus) *from the Maryland Miocene.*[1] W. Gardner Lynn and A. M. Melland, Johns Hopkins University. (Communicated by C. Lewis Gazin.)

A well-preserved skull taken from Zone 12 of the Calvert Formation of the Miocene about three miles south of Plum Point, Maryland, proves to be that of a marine catfish congeneric with the Recent gaff-topsail fish, *Felichthys felis.* This specimen provides the first record of a siluroid from these deposits and indeed appears to be the only complete skull of a fossil marine catfish yet known from North America.

The catfishes (Order Nematognathi) fall into some twenty-five families, most of the members of which inhabit freshwater streams and lakes. However, one large family, the Ariidae, contains about forty-five estuarine and marine genera, which are widely distributed in tropical and sub-tropical regions. The Nematognathi are represented but scantily in fossil records for, although a considerable number of fossil species have been described, the remains upon which most of them are based are too fragmentary to permit of any accurate de-

[1] Received November 18. 1938.

termination of their relations. The greater number of the fossil forms are known from the otoliths alone; others are represented by isolated fin spines or vertebrae; only a few well-preserved crania have ever been found.

In Europe, fossil members of the Nematognathi are known from deposits ranging from Lower Eocene to Pliocene and have been recorded from England, France, Belgium, Germany, Hungary, and Italy. Fossil catfishes have also been reported from the Middle Eocene of Sumatra, from the Miocene of Brazil, and from the Miocene of India. The literature pertaining to these records is to be found in Woodward's "Catalogue of the Fossil Fishes in the British Museum" (1901) and has been adequately reviewed by Leriche (1901). It therefore need not be discussed at length here.

In North America, the group is very poorly represented. Hay (1929) lists only twelve species of catfishes which have been described from deposits of the North American continent. Five of these have been assigned to the Recent genus *Ameiurus*, a freshwater group belonging to the family Ameiuridae. Since these freshwater forms differ rather widely from the marine catfishes it is not necessary to discuss them in connection with the present specimen. The other seven species were all described by E. D. Cope who erected for them a new genus, *Rhineastes*. The remains upon which these species are based are extremely fragmentary, consisting of small portions of skull plates, isolated fin-spines and otoliths. Nevertheless, they are sufficiently complete to indicate clearly that the genus belongs among the sea-catfishes so it has been assigned to the family Ariidae by Jordan (1923). Pertinent information is given in the following list:

R. arcuatus Cope 1873. Mid. Eoc. (Bridger) Wyo. Type, U.S.N.M. No. 3985. Spine and fragments.
R. calvus Cope 1873. Mid. Eoc. (Bridger) Wyo. Type, U.S.N.M. No. 3980. Fragments of cranium, dorsal spine.
R. pectinatus Cope 1874. Mioc. (Florissant) Colo. Type, U.S.N.M. No. 4086. Head and anterior part of skeleton.
R. peltatus Cope 1872. Mid. Eoc. (Bridger) Wyo. Type, U.S.N.M. No. 3984. Occipital-parietal bone and dorsal spine.
R. radulus Cope 1873. Mid. Eoc. (Bridger) Wyo. Type, U.S.N.M. No. 4099. Fragments of skull.
R. rhaeas Cope 1891. Oligoc. (Assiniboia) Canada. Abdominal vertebra.
R. smithii Cope 1872. Mid. Eoc. (Bridger) Wyo. Type, U.S.N.M. No. 3977. Basi-occipital, vertebrae, pectoral spine and articular of mandible.

The type specimens of *R. rhaeas* are figured by Cope (1891) and those of all the other species have been figured by Cope (1884). Examination of these figures and of the types themselves reveals the reason for the great difficulty which has been encountered in attempting properly to diagnose the genus and as Eastman (1917) remarks, "How closely *Rhineastes*, from the Green River Eocene, agrees structurally with modern species of siluroids cannot be determined, as it is known only by fragmentary remains." In any case, as will be shown, the present specimen shows such well-marked affinities with the modern genus *Felichthys*, that we have no hesitation in referring it thereto.

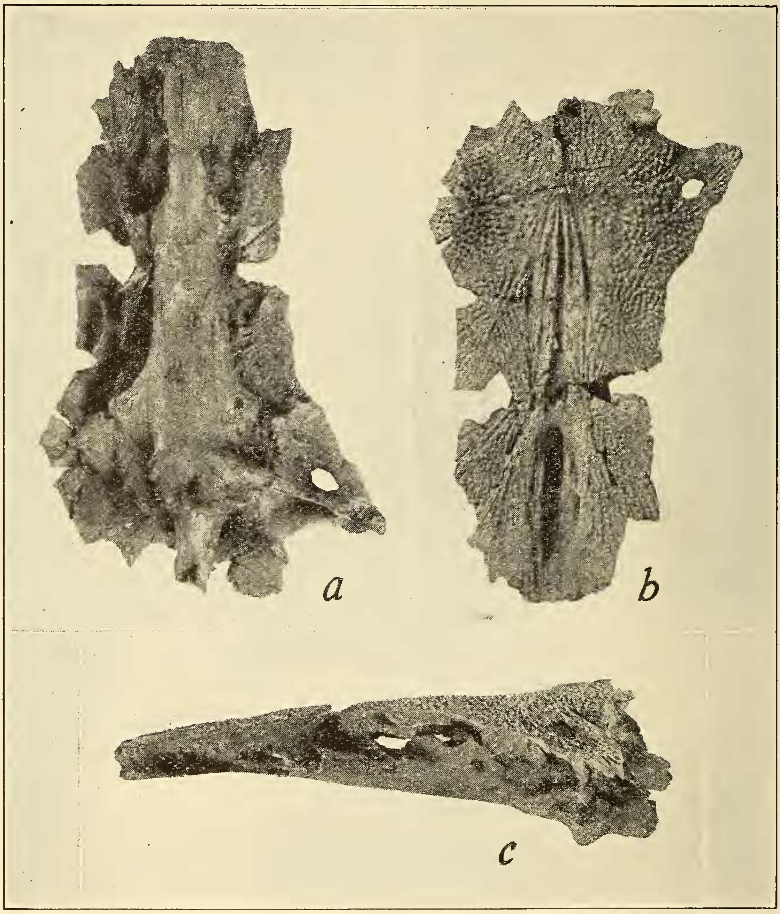

Fig. 1.—*Felichthys stauroforus*, n. sp. Skull, type specimen, U.S.N.M. No. 15746. *a*, ventral aspect. *b*, dorsal aspect. *c*, lateral aspect. All views $\times \frac{1}{2}$.

Felichthys stauroforus, sp. nov.

Type.—U.S.N.M. No. 15746. A nearly complete skull and the left utricular otolith from the same specimen.

Type locality.—Zone 12, Calvert formation of the Miocene, three miles south of Plum Point, Maryland.

Description of skull.—As may be seen from the figures (1a, 1b) the most important deficiency in this specimen is the absence of the most anterior skull bones; the ethmoid, prefrontals, premaxillae and vomer. The right post-temporal and the posterior portion of the supraoccipital have also been lost. All the other bones are practically intact and have suffered no notice-

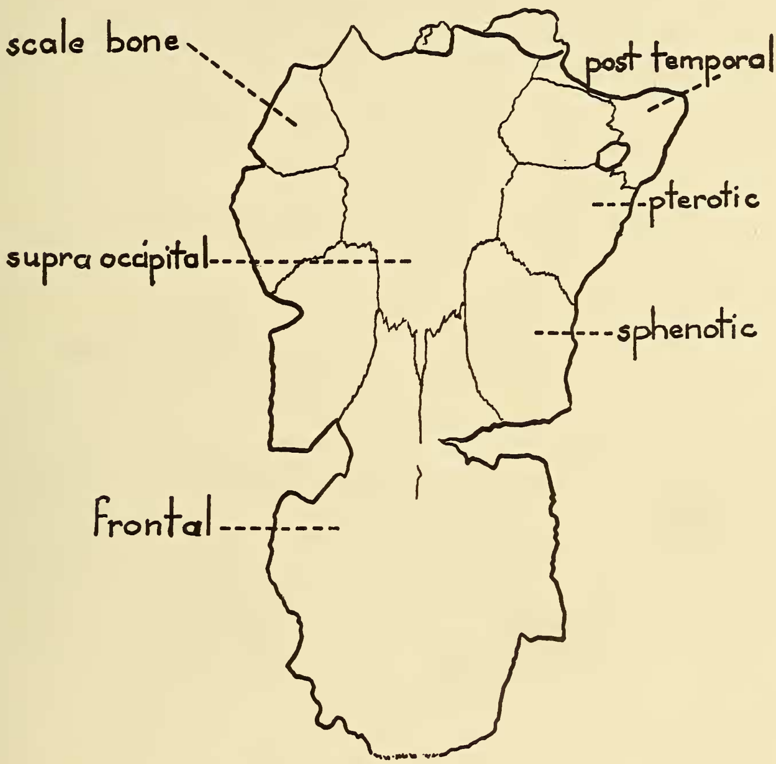

Fig. 2.—*Felichthys stauroforus*, n. sp. Dorsal aspect of skull showing outlines of bones. $\times\frac{3}{4}$.

able distortion. The sutures of the dorsal surface are well-marked and reveal the outlines of the various plates to be as shown in figure 2. The frontals, which form the anterior part of the specimen as preserved, narrow posteriorly and are separated at their hinder extremities by the narrow anterior projection of the supraoccipital. Two frontal fontanelles are present; the anterior, elongate one measuring 32 mm. The sphenotics which contact the posterior lateral borders of the frontal are rather large and take part in the formation of the lateral edge of the skull. They are in relation with the frontals, the supraoccipital and the pterotics. Their lower surfaces bear prominent arched ridges bordering deep depressions, the points of attachment for the hyomandibular. The pterotics, which lie behind the sphenotics, articulate medially with the supraoccipital and posteriorly with paired bones which apparently represent the "scale bones" figured by Gregory (1933) in

Chrysichthys. Laterally the pterotic forms a part of the lateral border of the skull but, at its posterior lateral end, articulates by a blunt process with an anterior process of the post-temporal. Since the scale bone which lies behind the pterotic articulates similarly with a posterior process of the post-temporal, a foramen bordered by the pterotic, scale bone and post-temporal is formed in the posterior lateral portion of the skull. This foramen measures 9 mm by 5 mm. In the under side of the skull the post-temporal articulates by a long bar of bone with the basioccipital. The supraoccipital, which contacts all the bones above described except the post-temporal, has a thin anterior projection between the two frontals and its lateral margins are indented by a series of curves where the plate is united with the frontals,

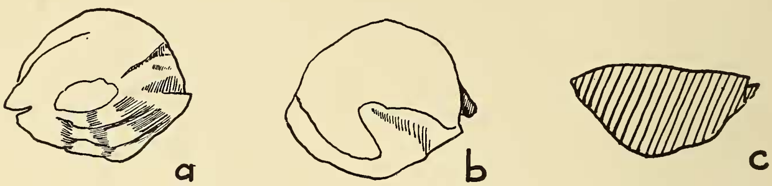

Fig. 3.—*Felichthys stauroforus*, n. sp. Left utricular otolith. *a*, inner surface. *b*, outer surface. *c*, diagrammatic section.

sphenotics, pterotics and scale bones. The hinder portion of the supraoccipital is missing but the bone evidently narrowed posteriorly. There is a prominent crest in the mid-line of the posterior half of this bone, but anterior to this is the beginning of the deep median depression in which lie the frontal fontanelles.

The dorsal surfaces of all the skull bones are ornamented with rounded projections which are arranged in definite rows, the individual projections in each row being connected by a low ridge. These rows of projections tend to radiate from the centers of the bones toward the edges. Crossing the scale bone, the pterotic and the sphenotic are rather ill-defined grooves which may indicate the courses of the lateral line canals.

On the under surface of the skull the sutures are ill-defined and slight crushing of the otic region on the left side makes exact description of the bones of this region difficult. The cruciform structure formed by the basioccipital and parasphenoid and the ventral processes of the post-temporals, which is a distinctive characteristic of the skull of the Ariidae and which has been most interestingly discussed and figured by Gudger (1925), is a striking feature in this specimen and suggests the specific name *stauroforus* (cross bearing). At the posterior end of the skull a portion of the mass of bone formed by coalescence of the centra of the anterior vertebrae is preserved. This is fused anteriorly with the basioccipital, the point of fusion being marked by a large, rounded ventral projection. Immediately anterior to this is a foramen leading into the centra of these vertebrae. The ventral process of the post-temporal articulates with the basioccipital just anterior to this foramen. Only that of the left side is preserved. The otic capsules, which house the large otoliths, lie laterally in this region. The deep depressions in the ventral sides of the sphenotics for attachment of the hyomandibular lie anteriorly to the otic capsules. In front of these the skull broadens to a fan-shaped mass, made up of the parasphenoid and the under sides of the frontals.

The skull, as preserved, has a maximum length of 139 mm and a maximum width of 84 mm. Since figure 2 is drawn to scale it is unnecessary to give complete measurements of the individual bones.

Description of otolith.—Since the otoliths of the fishes frequently furnish reliable diagnostic characters it seemed advisable to attempt to recover the otoliths in this specimen. A narrow break already present in the right wall of the cranium made it possible to clear away some of the matrix inside the brain case without injury to the skull. Fortunately the otoliths were found to be present and the left one was removed practically intact. The right otolith has been left within the skull.

In studying this otolith extensive use has been made of Frost's (1925) excellent descriptions and figures. The specimen is of large size (14 mm long and 12 mm high) and agrees with Frost's description of the utricular otoliths of the Ariidae in being conchoidal and biconvex. The inner surface (figure 3a) is rugose with a number of concentric ridges. A posterior process with a slight indentation is present but it has been damaged. The anterior process is rounded. The dorsal rim of otolith is rounded while the ventral rim is truncated posteriorly and indented slightly just behind one of the strong, radiating ridges. The outer surface (figure 3b) has a roughened band along the entire ventral rim with a broad, recurved projection just behind the middle. The rest of this surface represents the smooth sulcal area. The outer surface (figure 3c) is much less convex than the inner. Comparison of this otolith with Frost's figures for members of various families of the Nematognathi immediately confirms the identification of the present specimen as belonging to the Ariidae, for the otoliths in this family are easily distinguishable from those of other siluroids by their large size, their form and the shape and location of the sulcal area. Moreover, among the species considered by Frost the otoliths of *Felichthys marinus* are definitely closest to the present specimen.

The association of this fossil with the genus *Felichthys* on the basis of skull characters is thus confirmed by the structure of the otolith.

As has been pointed out, only a very few well-preserved skulls of fossil catfishes have ever been reported. One of these, however, that of *Bucklandium diluvii*, is especially noteworthy as being the earliest true siluroid known. This specimen from the London Clay (Lower Eocene) of Sheppey, was first figured by König (1825) who regarded it as representing a lizard. Morris (1843) later recognized its piscine nature, but it was not until 1889 that Woodward assigned it to the siluroids. Jordan (1923) places the genus *Bucklandium* in the family Bagridae. A skull from the Upper Eocene of Barton has been described and figured by Newton (1889) who refers it to the fossil species *Arius crassus*, a form previously known only from the otoliths. This specimen is sufficiently complete to be comparable with the skull described in this paper, from which it differs in the absence of the posterior frontal fontanelle, the absence of the post-temporal vacuity and the shape of the supraoccipital.

Ameiurus primaevus, described by Eastman (1917) is perhaps the best known of all the fossil catfishes, since it is represented by a nearly complete skeleton. The origin of this specimen is unknown, though the nature of the matrix indicates that it came from the Green River Eocene of Wyoming.

It is unfortunate that the relations of *Felichthys stauroforus* with the only other known fossil Ariidae from North America, those of the genus *Rhineastes*, cannot be ascertained. However, the fact that in *Rhineastes* the frontal fontanelle is completely closed, may be taken to indicate that the relationship is not close.

The present-day members of the genus *Felichthys* are predominantly subtropical in distribution. *Felichthys felis*, according to Gudger (1916) "ranges as far north as Cape Cod, but is especially common along the South Atlantic and Gulf coasts where it is abundant in brackish waters, for which it seems to have a predilection." Eigenmann and Eigenmann (1890) state that it is found along the Atlantic coast from Cape Cod to Rio de Janeiro. Maryland is thus included in the present range of the genus, but it appears to be most common further south. In view of this distribution of the modern representatives of the group, this record of *Felichthys* from the Maryland Miocene may be an addition to the gradually accumulating evidence, which has been recently discussed by Collins and Lynn (1936), that the temperatures in Maryland during the Miocene were somewhat higher than they are today.

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